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XLIX.—*On the Reticularian and Radiolarian Rhizopoda (Foraminifera and Polycystina) of the North-Polar Expedition of* 1875–76. By Henry B. Brady, F.R.S.

[Plates XX. & XXI.]

Foraminifera.

Amongst the collections brought home by Capt. H. W. Feilden, R.A., the naturalist to the North-Polar Expedition which sailed in 1875 under the command of Capt. Sir G. Nares, R.N., were a number of gatherings of material which had been laid aside from time to time for examination with respect to Microzoa and Microphyta. There were in all some fifty or sixty packages; and after the Diatomaceæ had been determined, Capt. Feilden was kind enough to place them in my hands for the investigation of the Foraminifera and Polycystina. The material consisted for the most part of soundings; but there were a few samples of dust and dirt from discoloured ice, and of mud from beds of glacial deposit of greater or less age. The soundings were from depths of from 10 to 220 fathoms; and the quantity of each was comparatively small. The samples from mud-beds were larger, and yielded pretty good series of Foraminifera; but as they exhibit a fauna which is practically identical with that of the present sea-bottom at moderate depths in the same latitudes, they require no separate treatment. The dust from ice-hummocks and similar positions gave no Rhizopoda worth recording.

All the material was carefully washed to clear it of impalpable inorganic matter. This process seriously reduced many of the already small samples; and some of them left scarcely any residue for examination. Nevertheless of the fifty or sixty gatherings about forty yielded sufficient organic remains to give a general, though of course not an exhaustive, idea of the microzoic fauna of their respective localities. In some instances a number of the soundings were from points so near together and at depths so similar, that the results from several could be incorporated with advantage; but after condensation on this wise, and the omission of a few of those which gave obviously incomplete lists, there remains the groundwork for a fairly representative distribution-table comprising twenty-four stations. This must be regarded, under the circumstances, as very satisfactory. The primary object of the expedition was geographical rather than biological; there was no opportunity for dredging; and the chances of obtaining material in other ways were beset with difficulties hardly to be appreciated by those who, like myself, have been accustomed to collect in temperate regions.

The following is a list of the Stations arranged in order of latitude, beginning at the most southern point of the series. The geographical details, thanks to careful labelling, can be stated with much accuracy. The capital letters A to X refer to the heading of the columns in the accompanying Table. The area comprised in the Table may be divided into three sections. The first sixteen columns (A to P) refer to localities in Baffin's Bay and Smith Sound. These are separated by the whole length of Kennedy Channel (nearly two degrees) from Discovery Bay (Q), the only representative of the latitude of Hall Basin. Robeson Channel (nearly one degree) intervenes between this and the nearest of the seven remaining Stations.

A. Glacial mud, Tyndall Glacier, 27 fathoms, Sept. 12, 1876, situate in Bardin Bay, east side of Baffin's Bay, lat. 77° 15′ N.

A little box of reddish clay with worn shell-fragments, containing relatively but few organisms; the Foraminifera belong chiefly to the genera *Verneuilina*, *Cassidulina*, *Truncatulina*, and *Nonionina*.

B. Off Cape Isabella, 220 fathoms, lat. 78° 20′ N.

This is the deepest sounding containing Foraminifera; but it is richer in Diatomaceæ (notably *Coscinodiscus radiatus*) than in Rhizopoda. Of the latter, *Cassidulina*, *Truncatulina*, and *Nonionina* are again the most prominent types.

48.
49.
50.
51.
52.
53.

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TABLE SHOWING THE DISTRIBUTION OF ARCTIC FORAMINIFERA.

		Tyrahll Glacier, 27 fms. Lat. 72° 15′ N.	Off Cape Isabella, 220 fms. Lat. 75° 30′ N.	Off Cape Sabine, 50 fms. Lat. 78° 44′ N.	Off Brevoort Island, 210 fms. Lat. 78° 44′ N.	Off Cape Victoria, 35 fms. Lat. 79° 14′ N.	Between Wilrus Shoal and Victoria Head, 35 fms. Lat. 79° 23′ N.	Franklin-Pierce Bay, 13 and 15 fms. Lat. 79° 38′ N.	Franklin-Pierce Bay, 46 fms. Lat. 79° 28′ N.	Allman Bay, 28 fms. Lat. 79° 30′ N.	Dobbin Bay, 43–47 fms. Lat. 79° 35′ N.	Dobbin Bay, 113 fms. Lat. 79° 35′ N.	Dobbin Bay, 120 fms. Lat. 79° 35′ N.	Off Hayes Point, 22 fms. Lat. 79° 42′ N.	Off Hayes Point, 35 fms. Lat. 79° 42′ N.	Off Cape Fraser, 50 fms. Lat. 79° 45′ N.	Off Cape Fraser, 40 fms. Lat. 79° 45′ N.	Discovery Bay, 24–28 fms. Lat. 81° 41′ N.	Floid Valley. Lat. 82° 8′ N.	Ravine, Repulse Bay. Lat. 82° 10′ N.	Winter Quarters of 'Alert.' 4 fms. Lat. 82° 27′ N.	Mud-beds, 150 feet elevation. Lat. 82° 27′ N.	Flotberg Beach. Lat. 82° 29′ N.	Cane Ravine. Lat. 82° 33′ N.	Sounding, May 11, 1876. 72 fms. Lat. 83° 19′ N.	Coast of Norway. Lat. 68° to 71° N.	Hunde Islands. Lat. 68° 60′ N.	Baffin's Bay. Lat. 74° 47′ to 76° 30′ N.	
		A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.	V.	W.	X.	From Messrs. Parker and Jones's Table. *a.*	*b.*	*c.*	
1.	Cornuspira foliacea, *Phil.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	1.
2.	—— involvens, *Reuss*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	*	..	..	..	2.
3.	Triloculina tricarinata, *D'Orb.*	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	*	..	3.
4.	Quinqueloculina seminulum, *Linné*	..	*	..	..	..	..	..	..	..	*	*	..	..	..	*	*	*	..	..	..	..	..	..	*	*	*	..	4.
5.	—— subrotunda, *Montag.*	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	*	*	*	*	5.
6.	Lituola fusiformis, *Will.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	6.
7.	—— scorpiurus, *Montfort*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	7.
8.	—— canariensis, *D'Orb.*	*	..	..	*	..	..	*	..	..	..	..	..	*	*	..	*	*	..	..	..	..	..	..	..	..	*	*	8.
9.	—— glomerata, *nov.*	..	*	..	..	*	*	..	*	*	*	*	..	..	..	..	*	*	..	..	..	*	..	..	..	*	*	*	9.
10.	Hyperammina elongata, *nov.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	10.
11.	Lagena globosa, *Montag.*	..	..	..	*	*	..	..	..	*	..	..	*	..	..	..	*	*	..	..	..	..	..	..	..	..	*	*	11.
12.	—— lævis, *Montag.*	..	..	..	..	..	..	..	..	*	*	*	*	..	..	..	*	*	..	..	..	..	..	..	..	*	..	..	12.
13.	—— marginata, *W. & J.*	..	..	*	..	..	..	..	..	*	*	*	*	..	..	..	*	*	..	..	..	..	..	..	..	*	..	..	13.
14.	—— apiculata, *Reuss*	..	..	..	*	*	..	..	*	*	*	*	*	..	..	..	*	*	..	..	..	..	..	*	*	*	*	..	14.
15.	—— sulcata, *W. & J.*	..	..	*	*	*	..	..	*	*	*	*	*	..	*	..	*	*	..	..	*	..	..	..	..	*	*	..	15.
16.	—— striata, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	*	*	..	16.
17.	—— striatopunctata, *P. & J.*	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	*	..	17.
18.	—— Feildeniana, *nov.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	*	..	18.
19.	—— caudata, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	*	..	19.
20.	—— melo, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	*	..	*	..	20.
21.	—— squamosa, *Montag.*	..	..	..	..	..	..	..	..	*	*	*	*	..	..	..	*	*	..	..	..	..	..	..	..	*	*	..	21.
22.	Olandulina lævigata, *D'Orb.*	..	..	..	*	..	..	..	..	*	*	*	*	..	..	..	*	*	..	..	..	..	..	..	..	*	*	..	22.
23.	Dentalina pauperata, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	*	*	..	23.
24.	—— communis, *D'Orb.*	..	..	..	..	*	..	..	..	*	*	..	*	..	..	..	*	*	..	..	..	..	..	..	..	..	*	*	24.
25.	Cristellaria rotulata, *Lamk.*	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..	*	*	*	25.
26.	Polymorphina lactea, *W. & J.*	..	..	..	*	..	..	..	..	..	*	*	..	..	..	*	*	..	..	..	..	..	..	..	..	*	*	..	26.
27.	—— compressa, *D'Orb.*	..	..	..	*	..	..	*	..	*	*	*	..	..	..	..	..	..	..	..	..	..	*	..	..	*	*	..	27.
28.	—— problema, *D'Orb.*	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	28.
29.	—— acuminata, *D'Orb.*	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	29.
30.	—— rotundata, *Bornem.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30.
31.	Spirillina vivipara, *Ehrenb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	31.
32.	Globigerina bulloides, *D'Orb.*, var.	*	..	..	*	*	*	*	*	*	*	*	*	..	*	*	*	*	..	*	*	..	*	..	*	*	*	*	32.
33.	—— inflata, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	33.
34.	Uvigerina pygmæa, *D'Orb.*, var.	*	*	..	*	*	..	..	*	..	*	*	*	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	34.
35.	Cassidulina lævigata, *D'Orb.*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	35.
36.	—— crassa, *D'Orb.*	*	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	36.
37.	Bulimina ovata, *D'Orb.*	..	..	..	..	..	..	..	..	..	..	..	..	*	*	*	..	..	*	*	..	..	..	*	*	..	*	*	37.
38.	—— elegantissima, *D'Orb.*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	38.
39.	Virgulina Schreibersii, *Czjzek*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	39.
40.	Bolivina punctata, *D'Orb.*	..	..	..	..	*	*	..	*	*	*	*	*	*	*	..	*	..	..	..	..	..	..	..	..	..	*	..	40.
41.	Textularia biformis, *P. & J.*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	41.
42.	Verneuilina polystropha, *Reuss*	*	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	42.
43.	Discorbina obtusa, *D'Orb.*	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	43.
44.	Truncatulina lobatula, *W. & J.*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	44.
45.	Pulvinulina Karsteni, *Reuss*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	45.
46.	—— Micheliniana, *D'Orb.*	..	*	*	*	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	46.
47.	Patellina corrugata, *Will.*	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	47.
48.	Nonionina scapha, *F. & M.*	*	..	..	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	..	48.
49.	—— umbilicatula, *Montag.*	..	*	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	49.
50.	—— depressula, *W. & J.*	*	..	..	..	..	*	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	50.
51.	—— stelligera, *D'Orb.*	..	..	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	51.
52.	Polystomella striatopunctata, *F. & M.*	*	*	..	*	*	..	..	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	..	52.
53.	—— arctica, *P. & J.*	*	..	*	*	*	..	*	*	..	*	*	*	*	*	*	*	*	..	*	*	*	*	*	..	*	*	*	53.

Additional Arctic species from the coasts of Greenland and Norway, enumerated in Messrs. Parker and Jones's Table.

54.	Nodosaria radicula, *Linné*	*	*	..
55.	Dentalina guttifera, *D'Orb.*	*	..	..
56.	Vaginulina linearis, *Montag.*	*	..	..
57.	Marginulina lituus, *D'Orb.*	*	..	..
58.	Cristellaria crepidula, *F. & M.*	..	*	..
59.	—— cultrata, *Montf.*	*	..	..
60.	Lagena distoma, *P. & J.*	*	..	..
61.	—— gracillima, *Sequenza*	*	..	..
62.	—— semistriata, *Will.*	..	*	..
63.	Polymorphina Orbignii, *Zbor.*	*	..	..
64.	Uvigerina angulosa, *Will.*	*	..	..
65.	Anomalina coronata, *P. & J.*	*	..	..
66.	Pulvinulina punctulata, *D'Orb.*	*	..	..
67.	Discorbina globularis, *D'Orb.*	*	*	..
68.	Polystomella crispa, *Linné*	..	*	..
69.	Nonionina asterizans, *F. & M.*	..	*	..
70.	—— faba, *F. & M.*	..	*	..
71.	Pullenia sphæroides, *D'Orb.*	*	..	..
72.	Nummulina planulata, *Lamk.*	..	*	..
73.	Operculina ammonoides, *Gron.*	*	..	..
74.	Bulimina pyrula, *D'Orb.*	*	..	..
75.	—— aculeata, *D'Orb.*	*	..	..
76.	Virgulina squamosa, *D'Orb.*	*	*	..
77.	Textularia agglutinans, *D'Orb.*	*	*	..
78.	—— pygmæa, *D'Orb.*	*	..	..
79.	Bigenerina nodosaria, *D'Orb.*	..	*	..
80.	Valvulina conica, *P. & J.*	*	..	..
81.	Trochammina squamata, *P. & J.*	..	*	..
82.	—— gordialis, *P. & J.*	..	*	..
83.	Quinqueloculina Ferussacii, *D'Orb.*	..	*	..
84.	—— agglutinans, *D'Orb.*	..	*	*
85.	Triloculina cryptella, *D'Orb.*	..	..	*
86.	—— oblonga, *Montag.*	..	*	..
87.	Biloculina ringens, *Lamk.*	*	..	..
88.	Lituola globigeriniformis, *P. & J.*	..	*	*

C. Off Cape Sabine, Smith Sound, 50 fathoms, lat. 78° 44′ N.

D. Off Brevoort Island, Smith Sound, 210 fathoms, lat. 78° 44′ N.

The former of these, from shallower water, contains but few species; the latter gives a tolerably rich list of Foraminifera—*Polystomella arctica* particularly fine and abundant, the genera *Lagena*, *Cassidulina*, *Truncatulina*, *Pulvinulina*, and *Nonionina* all well represented. There were in addition a few Ostracoda *.

E. Off Cape Victoria, Bache Island, 35 fathoms, lat. 79° 14′ N.

The genus *Truncatulina* by far the most abundant, associated with *Noninonia*, *Polystomella*, and other shallow-water types. Contained also Ostracoda of five species and a few *Coscinodisci*.

F. Between Walrus Shoal and Victoria Head, Sept. 8, 1876, 57 fathoms, lat. 79° 26′ N.

A poor lot, containing little beyond *Cassidulina*, *Nonionina*, and the weaker forms of *Polystomella*, with one or two Radiolaria. The only specimen of *Pulvinulina Micheliniana*, a common surface form in the North Atlantic, found in the entire collection, was in this material.

G. and H. Franklin-Pierce Bay, lat. 79° 28′ N.

The former (G) refers to two soundings, in 13 fathoms and 15 fathoms respectively; the latter (H) to two in 46 fathoms. The contents of all four were much alike, sandy mud with small worn stones; those from the greatest depth contained the largest variety of organisms. The salient types of Foraminifera in all are *Lituola*, *Truncatulina*, and *Polystomella*. The shallow-water material furnished the only specimens found of the genus *Discorbina*. It contained in addition a number of diatoms, which my friend Mr. F. Kitton, of Norwich, tells me are as follows:—*Triceratium arcticum*; *Biddulphia*, sp.; *Rhabdonema Crozieri*; *Grammatophora marina*; and *Actinoptychus undulatus*. A few valves of Ostracoda were also met with.

I. Allman Bay, Sept. 14, 1876, 25 fathoms, lat. 79° 30′ N. The Bay between Cape Hawks and Cape d'Urville.

A tube full of sand and stones, but rich in Foraminifera. The genus *Lagena* in considerable variety, with *Polymorphina*,

* The Ostracoda were carefully preserved throughout, and form the subject of a separate notice by my brother, Dr. G. S. Brady.

Cassidulina, *Pulvinulina*, and *Nonionina* as its prominent associates.

J, K, and L. Dobbin Bay, Aug. 28 to Sept. 1, 1876, lat. 79° 35′ N.

The column J includes three soundings, namely in 45, 46, and 47 fathoms, whilst K and L are from 113 and 125 fathoms respectively. The muddy material obtained in 46 fathoms contained the largest number of forms; in that from the greatest depth organisms of all sorts are rare. The leading types of Foraminifera are *Cassidulina*, *Pulvinulina*, and *Polystomella*.

M and N. Off Hayes Point, Aug. 18 and 19, 1876, lat. 79° 42′ N.

Two soundings, the one in 22, the other in 35 fathoms, containing a few Diatomaceæ and Ostracoda and a sprinkling only of Rhizopoda, the latter chiefly *Cassidulina* and *Truncatulina*, with *Virgulina*, *Pulvinulina*, and *Polystomella* in smaller numbers.

O and P. Off Cape Frazer, Aug. 24th, 1876, lat. 79° 45′ N.

The column marked O is compiled from a single sounding at 50 fathoms; that headed P is from three soundings, all at a depth of 80 fathoms. The latter taken together yield by far the best representative list of the whole series, comprising in all thirty-three species of Foraminifera. The most characteristic amongst them are *Polystomella arctica*, which is of large size and abundant, and the hitherto undescribed type *Hyperammina*. Almost all the genera contained in the other lists are present to a greater or less extent, the most important exception being *Polymorphina*. The same locality also gave the richest list of Ostracoda—eleven species, one of which is new to science.

Q. Discovery Bay, lat. 81° 41′ N.

Comprises two samples—one from 23 fathoms, the other from 25 fathoms. Rhizopoda rare and minute, chiefly *Cassidulinæ*, other genera being represented by very poor specimens.

R. Fiord Valley, near Lincoln Bay, lat. 82° 8′ N.

Mud taken from between the valves of shells; yielded little beyond *Cassidulinæ* and the weak varieties of *Polystomella*. The Ostracoda were of more importance and embraced one new species.

S. Mud from ravine north of Repulse Bay, lat. 82° 10′ N.

A little sandy glacial mud from Hall's Land, with the

label "brought by Mr. Egerton, April 1876." It contained but few specimens, and these of only four species. Though manifestly insufficient to show the extent of the fauna, they have been allowed a column in the Table as representatives of a region somewhat separated from the rest. Ostracoda were present, but in very small numbers.

T. Winter quarters of the 'Alert,' 1875–6, 6 fathoms, lat. 82° 27′ N.

Four tubes containing dried mud. Foraminifera chiefly of the genera *Globigerina*, *Cassidulina*, *Nonionina*, and *Polystomella*. Some of the tubes gave also a few Diatomaceæ (*Triceratium arcticum*) and occasional valves of Ostracoda.

U. Mud-beds, 150 feet elevation, lat. 82° 27′ N.

This material was found to be almost devoid of organic remains of any sort; the few specimens of Foraminifera were of quite the commonest species.

V. Floeberg Beach, July 1876, lat. 82° 29′ N.

A small tube of sand from the shore, and a pill-box with mud and stones from a depth of 10 fathoms, only furnished together what appears to be an incomplete list; and the specimens were all very small. There were a few Ostracoda also present.

W. Cane Ravine, June 1876, lat. 82° 33′ N.

A lot of finely divided silt, taken out of a specimen of *Astarte borealis*, from mud-beds 100 feet above the sea-level, in Grinnell Land; containing small examples of a few of the common arctic types of Foraminifera and Ostracoda.

X. Sounding, May 11, 1876, 72 fathoms, lat. 83° 19′ N.

The most interesting sounding in the entire collection, not merely as being the most northerly, but also, considering the minute quantity that could be obtained for examination (only a few grains altogether), as presenting the most varied range of Microzoa. It consisted of fine soft mud containing Diatomaceæ (*Coscinodiscus radiatus*), Radiolaria in greater variety than any other sounding, and Foraminifera of no less than eleven genera, the most abundant of the latter being a dwarf variety of *Globigerina*.

In tracing on the map the area represented by this collection, and comparing it with that covered by previous researches, it becomes manifest that the ground is altogether new. Our present knowledge of arctic Rhizopoda is chiefly derived from the labours of Profs. W. K. Parker and T. Rupert Jones, and of the Rev. A. M. Norman. The memoir of Messrs. Parker and

Jones, in the 'Philosophical Transactions' for 1865, forms the text-book of the subject. It contains the results of the examination of the soundings taken by Sir E. Parry in Baffin's Bay, between latitudes 74° 45′ and 76° 30′ N.; of those of Dr. Sutherland off the Hunde Islands, on the west coast of Greenland, in lat. 68° 50′ N.; and of dredgings made by Mr. M'Andrew off the coast of Norway, between lat. 65° and 71° N. Mr. Norman's material consisted of dredgings brought home by Dr. J. Gwyn Jeffreys from his cruise in the 'Valorous,' the vessel, it will be remembered, which sailed in company with the 'Alert' and 'Discovery,' as far as Disco Island, on their northward voyage. The record of Mr. Norman's observations on the Rhizopoda, which, so far as they affect our present purpose, refer to an area lying between about lat. 59° and lat. 70° N., forms one section of the general scientific report submitted to the Royal Society. A notice by Dr. Carpenter of a few of the larger forms appeared at the same time.

Messrs. Parker and Jones's memoir is accompanied by a series of elaborate distribution-tables, one of which is devoted to the Arctic fauna. Of the twenty localities it comprises, seven belong to the group of soundings from Baffin's Bay, five to the Hunde Islands, and eight to the Norwegian coast. In all seventy-five species of Foraminifera are enumerated; and of these twenty appear in the Norwegian list only. A condensed statement of the results embodied in Messrs. Parker and Jones's Table will be found in the three columns (*a*, *b*, *c*) appended to that which accompanies the present paper. A ready means of comparison is thereby afforded, and the subject need not, therefore, be further dwelt upon.

The 'Valorous' report cannot, unfortunately, be treated in the same way, as it contains no detailed lists of the Foraminifera. I propose, therefore, in order to complete the summary of what has been hitherto written on the subject, to cull from the Rev. A. M. Norman's paper (Proc. Roy. Soc. vol. xxv. pp. 207–213) such particulars as he gives relative to the distribution of species in those localities that come within the sphere of our present inquiry. Having had the opportunity of looking over the fine collection of Foraminifera obtained from the 'Valorous' material, I may be permitted to express my regret that circumstances have hitherto prevented Mr. Norman from giving his results to the world. They are of great interest and cost much labour; and the details would have been a valuable contribution to the literature of the Rhizopoda. Four of these dredgings were from points within the Arctic Circle; and two others, from the Stations num-

bered 8 and 9 respectively, though not strictly arctic in latitude, pertain to an adjacent and much richer zoological area, and are within Davis Straits, which may be regarded as a sort of natural boundary. The following notes are abstracted from Mr. Norman's summary.

Holsteinborg Harbour (lat. 66° 40′ N.), 7–35 fathoms.

The more remarkable Foraminifera were:—*Trochammina gordialis*, J. & P.; *Lituola canariensis*, D'Orb.; *Textularia biformis*, P. & J.; and *Bolivina punctata*, D'Orb.

Godhavn Harbour, Disco (lat. 69° 10′ N.), 5–20 fathoms.

Thirty-six species identified, amongst them:—*Dentalina consobrina*, D'Orb. (fide P. & J.), *Polymorphina burdigalensis*, D'Orb.; *Pullenia sphæroides*, D'Orb.; *Verneuilina polystropha*, Reuss; *Cassidulina obtusa*, D'Orb.; *Pulvinulina Karsteni*, Reuss; and *Discorbina obtusa*, D'Orb.

Lievely Harbour, Disco (lat. 70° N.*), 5–20 fathoms.

The Foraminifera exhibited a marked parallelism with those recorded by Mr. G. M. Dawson from Gaspé Bay†, in the Gulf of St. Lawrence. Twenty-eight species were noted, including:—*Rhabdopleura abyssorum*, Parker; *Lituola cassis*, Parker; *Nonionina labradorica*, Parker; and *Bulimina pyrula*, D'Orb.

Station No. 5. Lat. 66° 59′ N., long. 55° 27′ W., 57 fathoms.

Thirty-five Foraminifera observed, ten belonging to the genus *Lagena*. The list contains, amongst others:—*Lagena striatopunctata*, P. & J.; *Lituola globigeriniformis*, P. & J.; *Cyclammina cancellata*, H. B. Brady, MS.; and *Bulimina elegantissima*, D'Orb.

Station No. 8. Lat. 62° 6′ N., long. 55° 56′ W., 1350 fathoms.

Contained many of the more common Foraminifera. The following are noted:—*Nodosaria Schlichtii*, Reuss; *Orbitolites tenuissimus*, Carpenter; *Pullenia quinqueloba*, Reuss; and *Lituola nautiloidea*, Lamk.

Station No. 9. Lat. 59° 10′ N., long. 50° 25′ W., 1750 fathoms.

Remarkable for the abundance and variety of arenaceous

* The latitudes of Holsteinborg, Godhavn, and Lievely Harbours are not given in the Report, and the last of the three does not appear in any map I have access to; but, for the purpose of comparison with the range of the other localities, the figures stated are near enough.

† It must be remembered, nevertheless, that Gaspé Bay is in lat. 48° to 49° N., or fully a degree south of the coast of Cornwall, though more or less Arctic in climatal conditions.

types, e. g. *Rhabdammina*, *Pilulina*, most of the various forms described as *Lituolæ* by Dr. Carpenter, and *Astrorhiza catenata*, Norman. In addition to these, *Cristellaria obvelata*, Reuss, *Orbulina neojurensis*, Karrer, and the dwarf variety of *Globigerina bulloides*, alluded to on a later page of the present paper, were also found.

To turn now to the more strictly zoological portion of the subject. An examination of the accompanying Distribution-Table, still more the inspection of the mounted specimens, brings into relief certain characteristics of the Polar foraminiferal fauna. Some remarks will presently be made on the individual species where they exhibit any special or noteworthy features; but attention may be drawn at the outset to one or two facts of more general import. There are about half a dozen species that may be regarded as essential constituents of the microzoic fauna of these high latitudes, having been found at almost every depth at which the floor of the sea has been examined. They are as follows—*Globigerina bulloides* (a dwarf variety), *Cassidulina lævigata* and *C. crassa*, *Truncatulina lobatula*, *Pulvinulina Karsteni*, and *Polystomella striatopunctata*. They are usually accompanied by one or two forms of *Nonionina*, varying according to depth and other circumstances, and, if the sea-bottom be composed of rough sand or gravel, by *Polystomella arctica*. Other species occur in every sample of mud or sand wherever obtained; but it is not too much to say that those above enumerated constitute ninety-five per cent. of the entire collection made from these soundings. The constant occurrence of *Cassidulina lævigata*, of full size and well-grown, even when the other Foraminifera accompanying it were poor, starved specimens, and the presence of *Pulvinulina Karsteni* in almost every dredging to the practical exclusion of all other species of the same genus, are points of considerable significance. The almost complete absence of the Milioline genera (for the occurrence of a single, minute, thin-shelled specimen here and there in a few of the soundings amounts to absence in such a case) is an unexpected feature. In dredgings at similar depths but little to the south of those under consideration the simple porcellanous forms are comparatively common; and their area of distribution is otherwise world-wide; yet it is hardly too much to say that no approach to a full-sized mature specimen of any of the modifications of the Milioline type has been met with in the North-Polar material.

One or two of the species are undescribed hitherto; and a few others present characters somewhat modified by their

boreal habitat. The following notes refer to some of these; the numbers prefixed correspond with those employed in the Table. The new forms and the more interesting varieties are figured in Plates XX. and XXI.; for the rest, nearly all the species are well illustrated in Messrs. Parker and Jones's memoir before referred to, or in Prof. Williamson's 'Recent Foraminifera of Great Britain.'

9. *Lituola glomerata*, nov. (Pl. XX. fig. 1, *a–c*.)

Characters. Test free, arenaceous, thin-walled, non-labyrinthic; spiral in arrangement, subglobular in form, often somewhat lengthened in the direction of the axis; usually more or less unsymmetrical. Segments few, three or four in each convolution, long, narrow. Sutures but little excavated except at the ends. Aperture at the inner margin of the terminal chamber, near the exterior of the corresponding segment of the previous convolution, simple, often obscure. Diameter of the test seldom more than $\frac{1}{100}$ inch (0·25 millim.).

This, which is perhaps the most minute of the segmented Lituolida, is an obscure and difficult form to treat. The septation is often imperfect and sometimes cannot be traced on the exterior. The drawings (Pl. XX. fig. 1, *a–c*) are from unusually good specimens, and they are sufficiently characteristic. When the Lituoline genera come to be rearranged in the light of the material which now exists for their more extended and accurate study, it is possible that this, in common with some other of our northern species, may find its place in Reuss's genus *Haplophragmium*; but its nearest allies are forms best recognized at present under the generic term *Lituola*. In distribution *Lituola glomerata* is by no means confined to the arctic seas, but has been met with in the 'Challenger' dredgings from many parts of the world.

10. *Hyperammina elongata*, nov. gen. et sp.
(Pl. XX. fig. 2, *a*, *b*.)

Characters. Test arenaceous, in the form of a straight or nearly straight tapering tube, the wide end closed and rounded, the open narrow end constituting the general aperture. Exterior sandy and rough, interior smooth. Length (of the Arctic specimens) about $\frac{1}{10}$ inch (2·5 millims.).

This is one of the many arenaceous types brought home in 1869 by the naturalists in charge of the first cruise of the 'Porcupine;' but it has not hitherto, so far as I am aware, received a name. Its club-like or, still more, its pestle-like contour and sandy texture, suggest the term *Hyperam-*

*mina**. The polar specimens are very small when compared with those from the North Atlantic, or with those from many of the 'Challenger' stations—examples considerably more than half an inch (15 or 16 millims.) being not unfrequent in other localities.

14. *Lagena apiculata*, Reuss.

The somewhat compressed as well as the globose forms are included under this name.

17. *Lagena striatopunctata*, Parker & Jones. (Pl. XX. fig. 3.)

A few specimens similar in character to those figured by Messrs. Parker and Jones were met with in two of the deeper soundings.

18. *Lagena Feildeniana*, nov. (Pl. XX. fig. 4.)

Characters. Test subglobular, pyriform, with surface-ornamentation consisting of a few stout longitudinal costæ alternating at regular distances with longitudinal rows of large perforations. Longer diameter about $\frac{1}{70}$ inch (0·37 millim.).

A very pretty little shell, with somewhat striking superficial ornament. It bears considerable resemblance to two other costato-perforate species, namely *Lagena striatopunctata*, P. & J., and *L. Howchiniana*, Brady. The former of these has a double row of minute pores bordering each riblet (Pl. XX. fig. 3); the latter, which is a Carboniferous species, has a single row of orifices down the top of each ridge; whilst *L. Feildeniana* is distinguished by stout entire costæ with a single series of large pores in the furrows between them. As this particular varietal form does not appear to have been hitherto observed or described, it may very properly be associated by name with the naturalist to whom we owe the North-Polar collections.

Hab. Off Cape Frazer, 80 fathoms.

19. *Lagena caudata*, D'Orbigny.

A single entosolenian specimen, not unlike that figured by Williamson as *Entosolenia globosa*, var. *lineata*, Rec. For. Gt. Br. pl. i. fig. 17.

22. *Glandulina lævigata*, D'Orbigny.

From 80 fathoms off Cape Frazer, very rare; an elongate variety resembling *G. gracilis* of Reuss, though not quite so attenuated and sharp-pointed.

* ὕπερος (a pestle), ἄμμος (sand).

25. *Cristellaria rotulata*, Lamarck.

Also one or two specimens approaching *C. crepidula* in contour.

26. *Polymorphina lactea*, Walker & Jacob.

Both typical pyriform specimens, and the compressed modification known as *P. lactea*, var. *amygdaloides*, Reuss.

29. *Polymorphina acuminata*, D'Orbigny. (Pl. XX. fig. 5, *a*, *b*.)
30. *Polymorphina rotundata*, Bornemann. (Pl. XX. fig. 6, *a*, *b*.)

Two interesting and somewhat rare forms, sufficiently illustrated by the figures. It is necessary, however, to bear in mind that the successive modifications of the genus *Polymorphina*, though generally pretty easily recognized, are of little more than varietal significance.

32. *Globigerina bulloides*, D'Orbigny, var. (Pl. XXI. fig. 10, *a*, *b*, *c*.)

Occasional specimens of the genus *Globigerina* occurred in most of the soundings; in one only were they present in sufficient abundance to constitute what we are accustomed to speak of as a *Globigerina*-ooze, namely in that from the most northerly point attained by the Expedition. The specimens differ considerably from the typical form—so much so that they can hardly be associated with it except as a variety. The shells are very small, compactly made, and nearly spherical; the individual segments are scarcely ventricose, and do not exhibit the globular contour that we are accustomed to regard as characteristic of the genus, nor do they open into a central or umbilical vestibule, but communicate directly with each other. The general aperture forms a semicircular or crescentic opening at the inferior margin of the terminal chamber. The Rev. A. M. Norman probably alludes to the same modification of the type in his description of specimens from a depth of 1750 fathoms in lat. 59° 10′ N., long. 50° 25′ W., one of the 'Valorous' stations just within Davis Straits*.

34. *Uvigerina pygmæa*, D'Orbigny, var. (Pl. XX. fig. 7, *a*, *b*.)

The *Uvigerinæ*, a very few specimens of which were found in several of the soundings, are uniform in their characters and

* Proc. Roy. Soc. vol. xxv. p. 212.

contour. They are minute, thin-shelled, and obscurely triangular; but the segments are more inflated than in the *Uvigerina angulosa* of Williamson, and the surface ornamentation is very partially distributed. They differ almost as much from the typical *U. pygmæa**; but the points of divergence are such as may and probably have been brought about by the different life-conditions of a polar climate. Such specimens may be accepted as representing a starved or impoverished variety of the typical form rather than a distinct species.

38. *Bulimina elegantissima*, D'Orbigny. (Pl. XXI. fig. 12.)

Very rare, and not of the precise contour by which the species is usually recognized: the segments are similarly arranged; but they are relatively shorter, and there are fewer in each convolution, as indicated in the figure.

41. *Textularia biformis*, Parker & Jones. (Pl. XX. fig. 8.)

A very minute, thin-shelled arenaceous species. Messrs. Parker and Jones's figures are on somewhat too small a scale to show the conformation of the test quite distinctly. The largest of the Polar specimens is but little over $\frac{1}{70}$ inch (0·37 millim.) in length.

42. *Verneuilina polystropha*, Reuss. (Pl. XX. fig. 9, *a–c*.)

Small specimens of this arenaceous triserial Textularian are common in one or two of the localities. They are often of the slender, more elegant form delineated in fig. 9, *a*.

45. *Pulvinulina Karsteni*, Reuss. (Pl. XXI. fig. 11, *a–c*.)

Over extensive areas, in almost every portion of the globe, the floor of the ocean is largely composed of the shells of Foraminifera belonging to two genera, *Globigerina* and *Pulvinulina*; but for the most part these are merely the dead skeletons of pelagic species which, when living, inhabit a layer of water that, comparatively speaking, may be regarded as superficial; but it is far otherwise in these high latitudes. A single chance specimen of *Pulvinulina Micheliniana* is the only representative of the pelagic section of the genus found in the entire collection of soundings; whilst *Pulvinulina Karsteni*, one of the many species that, so far as we know, live on the sea-bottom, is present everywhere, and the size and condition of the specimens indicate that it is at home in these northern regions.

* Compare Williamson's figures, Rec. For. Gt. Br. pl. 5. figs. 138–140, with fig. 7, *a*, *b*, of the present paper.